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THE FORMATION OF THE INTERIOR CELLS IN THE SEGMENTATION OF THE FROG'S EGG.

MARGARET REED.

Sections through the egg of the frog in the early stages of segmentation show that the cleavage planes extend from the surface inwards forming but one layer of cells. Later cleavage stages, however, show certain cells entirely within the interior of the egg, so that the cells of the dark pole appear to be arranged in two layers about the segmentation cavity.

Former observers supposed this appearance to be caused by a cleavage plane coming in parallel to the surface of the egg (delamination) probably between the 32- and 64-cell period.

Following Professor Morgan's suggestion, I attempted to determine whether a delamination really occurs or whether the interior cells are produced in some other way.

If the delamination occurs between the 32- and 64-cell stages we should expect to find the interval between these cleavage stages, as seen on the surface, longer than that between any two preceding divisions, because somewhere during this time, the cells would have divided by planes, which do not appear on the surface.

In order to test this point, I made a number of observations on the living egg, noticing the times of the surface divisions. I found no marked difference in the length of the interval between any two divisions, but the cleavage took place in a regular rhythm. There was usually a period of about one hour from the first appearance of segmentation in the cells of the dark pole until the next cleavage again began to appear there. This is shown in the following table.

	Beginning of 2-cell stage at dark pole.			
9:25 A. M.				
10:15 "	"	4	"	"
11:15 "	"	8	"	"
12:10 P. M.	"	16	"	"
12:55 "	"	32	"	"

1:50 P. M.	Beginning of 64-cell stage at dark pole.			
2:40 "	"	128	"	"
9:25 A. M.		8	"	"
9:30 "	"	16	"	"
10:35 "	"	32	"	"
11:35 "	"	64	"	"
12:25 P. M.	"	128	"	"
1:40 "	"	256	"	"

From this we see that if the delamination should occur between the 32- and 64-cell periods the division must take place at this period twice as fast as any other division. This of itself seemed improbable. I therefore preserved series of eggs taken every five minutes during the interval between the 32- and 128-cell divisions and later sectioned them in order to determine how the interior cells arise.

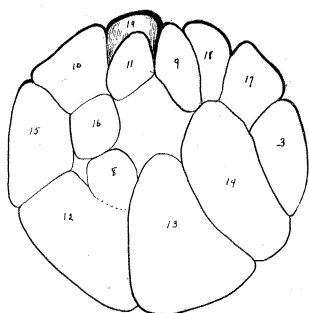
The eggs were cut about 20 μ thick and all the sections drawn with the aid of a camera lucida. Each cell of the egg was numbered and traced through the series of sections, in order to determine not only how many cells were present but also to ascertain how many came to the surface and how many were entirely inside. Two series taken every five minutes between the 32- and 128-cell stages were counted with the following as some of the results :

Supposed Number of Cells.	Actual Number of Cells.	Cells Inside.	Superficial Cells.
32	28	0	28
32	32	0	32
32-64	37	3	34
32-64	45	5	40
32-64	53	6	47
64	64	15	49
64-128	105	26	79

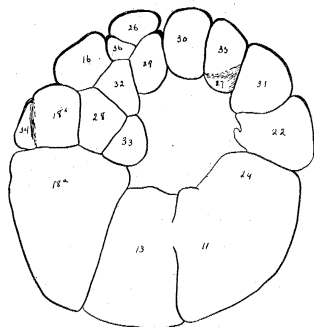
If delamination took place between the 32- and the 64-cell period, sections of an egg at the 64-cell stage should show 64 cells coming to the surface, plus a certain number of cells inside, but this, as the table shows, is not the case.

Sections through the egg as late as the end of the 32-cell stage show that all the cells are divided by cleavage-planes, which appear on the surface. Sections through the eggs of the series between the 32- and 64-cell stage show an increase

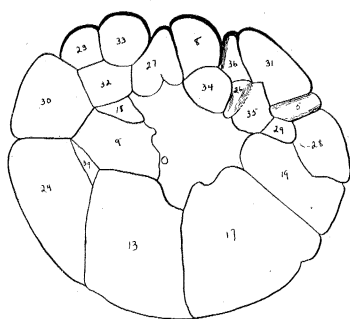
in the number of superficial cells¹ as well as of those which are wholly within the egg. At the end of the 64-cell stage there are 64 cells present in the egg, a number, about 12, of which do not appear on the surface. Also the series between the 64- and 128-cell cleavage stages show an increase in the number of cells coming to the surface, as well as the number of cells of the in-



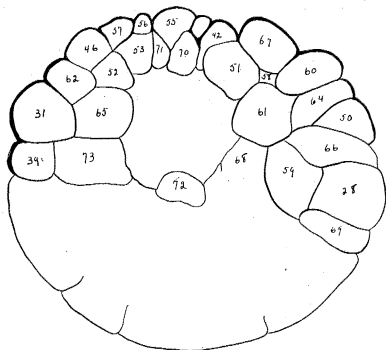
I



II



III



IV

terior, so that there is no cleavage stage between which and the following stage delamination takes place.

Figs. 1, 2, 3 and 4 show sections through the middle of eggs of 28, 53, 64 and 105 cells respectively. A number of cells in

¹ In the cleavage of the frog's egg, the division for the next cleavage stage begins in the cells of the dark pole, while the cells of the light pole are completing the division for the preceding cleavage stage.

these figures have the appearance of being pushed or crowded into the interior, that is, the portion of the cell which comes to the surface is quite small compared with the size of the cell which lies mainly within the egg.

This appearance of the cells seems to be caused by the division planes coming in more or less obliquely so as to cut off one cell with a small surface area as No. 9, Fig. 1. At the next cleavage, the division of this cell would give rise to one cell entirely within the egg and one coming to the surface. Cell 27, Fig. 3, shows the beginning of such a division while cell 70 or 71, Fig. 10, may have been formed in this manner. The following division of such a cell would then form cells lying entirely within the egg.

So far as I have been able to trace, the yolk cells also show no cutting off of interior cells during the early cleavage stages. Such a cell as 72 in Fig. 4, is but the end of a cell which other sections show coming to the surface.

These observations show that there is no delamination division cutting off a number of cells parallel to the surface but that the first formed cells of the interior are produced by the same division planes as are the cells of the surface and by their subsequent division form the cells of the interior.

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